CHEMICAL CONTENT OF PLANT SPECIES THAT HAVE BEEN EATEN BY DUSKY LEAF MONKEY (*Trachypithecus obscurus*) AT TAMAN PD UTAMA, PORT DICKSON, PENINSULAR MALAYSIA: A REVIEW

by

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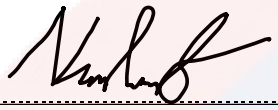
DECLARATION

I declare that this thesis entitled "Chemical Content of Plant Species That Have Been Eaten by Dusky Leaf Monkey (*Trachypithecus obscurus*) at Taman Pd Utama, Port Dickson, Peninsular Malaysia: A Review" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

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Chemical Content of Plant Species That Have Been Eaten by Dusky Leaf Monkey (*Trachypithecus obscurus*) at Taman PD Utama, Port Dickson, Peninsular Malaysia: A Review

ABSTRACT

A study to describe the Chemical Content of Plant Species That Have Been Eaten by Dusky Leaf Monkey (*Trachypithecus obscurus*) at Taman Pd Utama, Port Dickson, Peninsular Malaysia: A Review. The purpose of this study is to understandt the species, plant part and chemical content consumed by dusky leaf monkey at study area. Observations were conducted over 20 days, during which the group of approximately 12-18 individuals was monitored. The results show that the monkeys consumed a diverse range of plant species and parts, including leaves, young leaves, fruits, and unripe fruits. The nutritional composition of the consumed plants revealed varying levels of water, protein, carbohydrates, calcium, and fiber. The high water content in some fruits, such as rambutan, may be particularly important during the dry season when water availability is limited. The presence of high carbohydrates in the diet plays a crucial role in shaping the gut microbiota of the langurs, while a diet rich in fiber enhances digestive function and stool quality. The feeding habits of the dusky leaf monkeys are strongly influenced by the availability of different food sources in their environment, highlighting the importance of environmental factors in determining dietary preferences. This study provides valuable insights into the feeding ecology of dusky leaf monkeys, contributing to a better understanding of their adaptability and resource utilization strategies.

Kandungan Kimia Dalam Species Tumbuhan Yang Telah Dimakan oleh Lotong Celak (*Trachypithecus obscurus*) di Taman PD Utama, Port Dickson, Semenanjung Malaysia: Satu Tinjauan

ABSTRAK

Kajian untuk menerangkan Kandungan Kimia dalam Spesies Tumbuhan yang telah Dimakan oleh Lotong Celak (*Trachypithecus obscurus*) di Taman Pd Utama, Port Dickson, Semenanjung Malaysia: Satu Tinjauan. Tujuan kajian ini adalah untuk memahami spesies, bahagian tumbuhan dan kandungan kimia yang dimakan oleh monyet daun gelap di kawasan kajian. Pemerhatian telah dijalankan selama 20 hari, di mana kumpulan kira-kira 12-18 individu dipantau. Hasilnya menunjukkan bahawa monyet-monyet memakan pelbagai jenis spesies dan bahagian tumbuhan, termasuk daun, daun muda, buah-buahan, dan buah-buahan yang belum masak. Komposisi pemakanan tumbuhan yang dimakan menunjukkan paras air, protein, karbohidrat, kalsium dan serat yang berbeza-beza. Kandungan air yang tinggi dalam sesetengah buah-buahan, seperti rambutan, mungkin amat penting semasa musim kemarau apabila ketersediaan air terhad. Kehadiran karbohidrat yang tinggi dalam diet memainkan peranan penting dalam membentuk mikrobiota usus lutung, manakala diet yang kaya dengan serat meningkatkan fungsi pencernaan dan kualiti najis. Tabiat pemakanan monyet daun gelap sangat dipengaruhi oleh ketersediaan sumber makanan yang berbeza dalam persekitaran mereka, menonjolkan kepentingan faktor persekitaran dalam menentukan keutamaan diet. Kajian ini memberikan pandangan yang berharga tentang ekologi pemakanan monyet daun gelap, menyumbang kepada pemahaman yang lebih baik tentang kebolehsuaian dan strategi penggunaan sumber mereka.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

IUCN	International Union for Conservation of Nature
PD	Port Dickson

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Trachypithecus obscurus, or dusky leaf monkey also known in locally as "lotong celak", "lotong mata putih" or "lotong cekong" because of their white colour that surrounds their eyes. Dusky leaf monkey is a member of the colobine subfamily from the old world monkey. These arboreal primates are native to Southeast Asia and are frequently seen in the tropical rainforests of nations like Malaysia, Myanmar, Thailand, and Singapore (Traeholt et al, 2015). It also can be found on island near Malaysia such as, Penang, Langkawi, and Dayang Bunting island. The dusky leaf monkey's unique look and social behaviour are among its important characteristics. These monkeys are distinguished by their distinctive colouring, they have different colour following ages, which is bright orange when infant. After it become juvenile and adult the black greyish will appear (Guy, 2023). In 2015, the IUCN Red List of Threatened Species classified this species as Endangered (Traeholt et al, 2015).

Figure 1.0: Picture of *Trachypithecus obscurus*

From the previous study related to the behaviour of the dusky leaf monkey shown that the most of their time is eating with 30%, followed by moving (22%), grooming with 12%, 9% for fighting, playing (8%), vocalization (4%), nuisance (6) and sexual behaviour (3%) (Karimullah et al., 2014). This shows that throughout the day this dusky leaf monkey will spend a lot of time eating and moving around looking for food, there are also some of them doing pest behaviour. As folivores, dusky leaf monkeys mostly eat leaves, though they occasionally eat fruits, flowers, and seeds. They can process difficult plant materials with efficiency with their unique digestive mechanism. These monkeys have developed powerful limbs and prehensile tails to help them traverse and feed in the treetops. They are well-suited for an arboreal lifestyle (Yap et al,2019).

Senses play an important role in helping animals evaluate food, including fruits that can change in colour and smell when ripe to attract herbivores such as the dusky leaf monkey that eats leaves, fruits, and flowers ((Hodgkison et al., 2013). Fruit signals during ripening refer to traits like scent that have been preserved by natural selection due to their capacity to consistently transmit information to other organisms. (Valenta et al., 2016). To improve search efficiency for foraging behaviour of herbivorous mammals, they also use scent signals from food plants (Finnerty et al., 2017).

Location Taman PD Utama is a residential park located close to the forest which is suitable for this langur to live and forage. As they make use of the most numerous food leaves and are found there at the maximum biomasses, the species has a basic relationship with the upper layers of the dipterocarp rainforest (Yap et al., 2016). Therefore, this area is also often a focus for langur to find food and rest because the people here plant fruit trees such as mango and rambutan. In addition, yam shoots and moringa leaves are also the main food for this species. The studies from Karimullah et al (2014) found that the dusky leaf monkey looking for food in a residential area close to the forest inhabited by this langur.

1.2 Problem Statement

This problem statement explains that the issue of the escalating human-langur conflict in Port Dickson has become a critical concern, posing threats to the safety, well-being, and coexistence of humans and langur monkeys in the state. The period from January to May 2021 saw an alarming increase in complaints, with 8 cases reported to PERHILITAN, highlighting the pressing issue of harassment and attacks by langur against residents. This surge in conflict poses a major threat to the safety of the population, as interactions between humans and dusky leaf monkeys become increasingly uncertain. One of the most serious cases of injury due to this langur attack occurred on 21 January when a female victim was seriously attacked and bitten by a langur on the head, causing the victim's scalp to be torn and she was admitted to Port Dickson Hospital (Sulaiman, 2021). In addition, there is a significant lack of comprehensive studies to fully understand the causes and ways to overcome these conflicts more effectively without facing any issues.

1.3 Objective

To determine the chemical content of plant species that have been eaten by dusky leaf monkey.

1.4 Scope of Study

In this study, the focus is on providing a comprehensive analysis of the dusky leaf monkey's diet specifically within Taman PD Utama. It requires carefully recording the types of plants that dark leaf monkeys eat, thinking about the chemicals contained in these plants, and analysing how these dietary elements meet the nutritional needs of the species. The examination goes further to comprehend how their diet varies with the seasons and how these modifications impact their general well-being and nutritional status. It also contains an assessment of the research methodologies applied in this field of study, emphasizing the methods for chemical identification and dietary analysis. The study also addresses how the diets of dusky leaf monkeys may affect conservation, especially when it comes to habitat preservation and the availability of important food sources. By addressing these aspects, the study aims to offer a detailed understanding of the dietary ecology of dusky leaf monkeys in Taman PD Utama, contributing valuable information for conservation efforts and future research.

1.5 Significant of Study

The study of dietary and analysis of the chemical or nutrition that have been taken by *Trachipterus obscurus* is still lacking in research. A more detailed study of this species able to solve the problems faced. Food-related research on dusky leaf monkey is very important in Port Dickson because these dusky leaf monkey have been declared as pests and have harmed humans. Understanding the dietary preferences and nutritional needs of dusky leaf monkeys helps the creation of efficient habitat management strategies. This is particularly crucial for guaranteeing the sustainability of their populations and preserving the availability of essential food resources. The results of this study can help authorities such as PERHILITAN in the management and conservation of the dusky leaf monkey.

CHAPTER 2

LITERATURE REVIEW

2.1 Dusky Leaf Monkey

The dusky leaf monkey, or in scientific name is *Trachypithecus obscurus* is a member of subfamily Colobine. The dusky leaf monkeys are native to Myanmar, Thailand, and Malaysia including surrounding islands where they live in tropical forests (Traeholt et al, 2015). Playful, gregarious, and social dusky leaf monkey prefer to live in closed primary forests, but they can also be found in old-growth secondary and disturbed forests, plantations, urban areas, and parks, suggesting that they are adaptable compared to other colobine species (Posts, 2023). Dusky leaf monkeys are arboreal. They spent significantly more time in the 1 to 20 m deep lower to medium forest strata (Yap et al., 2019). However, primate habitats are being seriously impacted by the destruction and fragmentation of forests for human land use (Estrada et al., 2017). In 2015, the IUCN Red List of Threatened Species classified this species as Endangered (Traeholt, 2015).

Dusky leaf monkeys can be seen in different colors, depending on their age and sub-species. When they are infants, they exhibit striking orange fur which gradually changes to black and gray as they mature into adults (Ang et al, 2020). This transformation in coloration is a distinctive characteristic of their development. Typically, their fur appears slightly lighter in the dorsal area, extending down to the belly, creating a gradient effect. An intriguing feature of these monkeys is the bright white fur pattern around their eyes, often described as resembling spectacles, which adds to their unique and expressive appearance (Siti-Kauthar et al, 2019).

2.2 Diet Composition

Favourite food for this langur is a leaf, that's why they are called dusky leaf monkey. Belongs to the folivores, which are herbivores that specialize in eating leaves. This is because they have teeth that are suitable for digesting leaves, there are almost 90 species of trees that they choose to be their food. Besides feeding on leaves, flowers, ripe and unripe fruit. Dusky leaf monkey also feeds on rotten wood, clay soil, tree bark and insects. For this langur feed on insects is not normal for their diet to get additional minerals such as sodium and protein (rahman et al., 2016).

Colobines (*Presbytis thomasi*) and other monogastric primates, such as *Hylobates lar, M. fascicularis*, and *Pongo pygmaeus*, clearly differed from one another when it came to their preferred fruit consumption. Ungar (1995) examined the fruit preferences of four sympatric primates living in a primary lowland rain forest. Minerals are abundant in fruits and vegetables (Milton, 2003). Consumption of fruits and vegetables should be promoted since diets rich in them are associated with a lower risk of developing diseases like diabetes and cancer (Boeing et al., 2012).

2.2.1 List of The Plant That Eaten by Dusky Leaf Monkey

Table 1.1: Data food plant and plant part that consumed by Dusky leaf monkey.

No.	Species	Family	Local Name	Consumed
1	*Acacia auriculiformis*	Fabaceae	Earleaf Acacia	Leaves, fruits
2	*Albizia saman*	Fabaceae	Rain tree	Leaves, fruits, flower
3	*Archidendron jiringa*	Fabaceae	Jering	Leaves, fruits, flower
4	*Buchanania arorescens*	Anacardiacea	Otak udang	Leaves
5	*Millettia pinnata*	Fabaceae	Sea Milettia	Leaves, fruits, flower
6	*Peltophorum pterocarpum*	Fabaceae	Yellow flame	Leaves, fruits, flower
7	*Adenanthera pavovina*	Fabaceae	Red lucky seed	-
8	*Sandoricum koetjape*	Maliaceae	Sentol, santol	Leaves, fruits
9	*Ficus variegate*	Moraceae	Red steam fig	-
10	*Endospermum diadenum*	euphorbiaceae	Seduduk-seduduk	-

(Yap et al, 2019, Ruslin et al., 2018. Source: Journal)

2.3 Nutrition Content

Nutrition analysis is the process of determine the nutritional content of food that be related to the dietary composition significantly impacts the health and fecal consistency of dusky leaf monkey. The term "nutrition content" describes the information about the amount of nutrients, energy, or biologically active substances present in food. Understanding the nutritional content of foods is crucial for comprehending the dietary patterns of primates like the dusky leaf monkey. Research on primate species such as Mexican black howler monkeys and Assamese macaques has shown that primate food selection is influenced by a variety of nutrients, including protein, energy, lipids, and minerals (Righini et al., 2015).

2.3.1 Water contains/moisture.

A major factor in the dietary decisions made by langurs is the amount of moisture present in leaves, particularly in young leaves and fruit (Zhou Qi-hai, 2011). The importance of water content in food selection is highlighted by research on a variety of langur species, including White-headed langurs (*Trachypithecus leucocephalus*), Shortridge's langurs (*Trachypithecus shortridgei*) (Geng et al., 2020), and Francois' langurs (*Trachypithecus francoisi*) (Li & Elizabeth Rogers, 2006). Langurs' preference for young leaves is influenced by their higher water content, whereas their consumption of fruit is contingent upon the availability of moisture. Langurs exhibit a flexible dietary adaptation to maximize hydration and nutrient intake, which is essential for their survival and ecological adaptation in a variety of habitats. They base this adjustment on seasonal variations in water content.

2.3.2 Protein

Langurs' diets depend heavily on protein, particularly to balance their nutrient intake. The importance of protein in leaves, young leaves, and fruits for these primates is highlighted by research on a variety of langur species, including the Indochinese silvered langur, white-headed langur, and Shortridge's langur (Le et al., 2019). Fruits also play a major role in their diet, even though leaves are a staple food, with young leaves being especially important because of their high protein content (Li & Elizabeth Rogers, 2006) The nutritional makeup of these food sources, particularly the amount of protein, affects how the langurs feed and what they eat, suggesting that in order to meet their metabolic needs and preserve general health, they must consume a balanced diet of leafy greens and fruits high in protein. Thus, knowing how much protein is present in leaves and fruits is crucial to maintaining the health and preservation of langur populations across a range of habitats.

2.3.3. Fat

Langurs gain from the fat content of leaves because it gives them energy and vital nutrients that improve their general health and wellbeing. Higher fat content leaves have been demonstrated to be nutritive for langurs, supporting metabolic processes and helping to maintain body weight (Nijboer et al., 2006a). Furthermore, the fat content of leaves may contribute to better fecal quality in langurs, indicating improved nutrient absorption and digestion and ultimately beneficial effects on gastrointestinal health (Ibukun et al., 2022). Furthermore, the biomass of forest primates, including lemurs, has been connected to the protein-to-fiber ratio in leaves, which is influenced by fat content (Simmen et al., 2012). This finding emphasizes the significance of nutritional quality in leaves for primate populations in diverse forest ecosystems.

2.3.4. Calcium

Calcium plays a crucial role in the growth and development of plants, especially in leaves and young leaves, which are essential components of the diet of langurs. The highest concentration of calcium is found in leaves, which helps to protect cell walls and activate enzymes (Dayong et al., 2016). Since calcium is not very mobile within plants, its distribution is essential for healthy plant growth, and deficiencies are frequently caused by poor distribution rather than limitations on uptake (Kirkby & Pilbeam, 1984). A substantial amount of the langurs' diet is made up of leaves, with young leaves being especially significant as they make up between 55.7% and 66.4% of their total leaf intake (Gulbagca et al., 2020).

2.3.5. Carbohydrate

In the diet balance of langurs, carbohydrates are essential, particularly in the form of leaves, young leaves, and fruits. Studies reveal that langurs favor readily digested carbohydrates; in the absence of such a diet, they eat higher fiber diets (Mo et al., 2023). Improved feces consistency was observed in langurs when fruits and vegetables were eliminated from their diet. This improvement was correlated with increased dietary fiber intake and decreased dietary water. Furthermore, the nutritional makeup of leaves—in particular, the concentrations of water-soluble carbohydrates (WSCs)—is crucial for the ecology of langur feeding, and infrared spectroscopy has shown to be a quick and precise method for determining WSC concentrations in leaves that langurs eat (Nijboer, Clauss, et al., 2006). Fruits are regarded as healthy sources of carbohydrates, with different kinds of fruits having varied amounts of these nutrients. Therefore, it is important to understand the carbohydrate content of fruits. In general, the health and digestive system of langurs kept in captivity depends on a balanced diet of carbohydrates from leaves, especially young leaves, and fruits (a) Nijboer, Blijdorp, et al., 2006).

CHAPTER 3

MATERIAL & METHOD

3.1 Study Area

This study was carried out in Taman PD Utama (2°30'58.8"N 101°49'49.6"E) which is in the Port Dickson district, this area is located between forest and coastal areas which are suitable areas for habitat for dusky leaf monkey. The terrain for this area is flat and slightly hilly which is suitable for residents here to carry out recreational activities such as jogging, cycling, walking, and doing business. Around this housing estate there are large trees that are where these primates move to find food, rest, and play. In addition, the many electrical cable networks in this residential area make it easier for the primates that are here to move from the forest area into this residential area. Dusky leaf monkeys are primates that like to play on trees at a height of 10m or more, making electric cables a "bridge" for them to move from one area to another. Apart from the dusky leaf monkey (*Trachypithecus obscurus*), there are also primate species such as long-tailed macaques (*Macaca fascicularis*) and silvered-leaf monkeys (*Trachypithecus cristatus*). However, this study only focuses on the dusky leaf monkey (*Trachypithecus obscurus*).

Figure 3.1: The figure above shows the study area (Source: Google Maps 2023)

3.2 Material

The table below outlines the materials utilized in conducting research at Taman PD Utama, Port Dickson, Negeri Sembilan, to gather data on the species eaten by Dusky leaf monkeys.

Table 3.1: List and pictureof material

Material	Picture
Binoculars	
Camera	

(sources: Google image, 2023)

3.3 Method

3.3.1 Finding the Dusky Lead Monkey

The location of dusky leaf monkey groups was determined by walking around the study area. This group's search is focused on trees, electric cables, and the roofs of houses. Trees provide them with essential food and shelter, as they feed on leaves, fruits, and flowers while staying safe from predators. Electric cables have become part of their urban navigation, allowing them to move between areas when their natural habitat intersects with human settlements. The roofs of houses serve as additional pathways and vantage points, helping the monkeys to travel and find food in suburban environments. every road found in Taman PD Utama is traversed to find a group of dusky leaf monkeys. The weather conditions also affect the search when it rains this species is not found.

Figure 3.2: Area of finding dusky leaf monkey (Source: Google Maps 2023)

3.3.2 Observing the dusky leaf monkey eating activity.

To observe the group formation for data collection, binoculars were used whenever the dusky leaf monkeys were higher up in the tree to determine the species that have been taken by the group of dusky leaf monkey. This item helped to provide better views for the observation of the species it because maintained a safe observation distance of at least 3 meters from the dusky leaf monkey or afar as the species felt shyness and run into the forest while being observed (Karimullah, 2014). Although we could approach them closer without provoking a flight reaction.

3.3.3. Collecting Data and Identify

The camera was used to capture images of a plant or its parts, such as leaves, flowers, or fruits, which could then be used to identify the plant species by referring to field guides, books, trusted websites, or asking experts for assistance. The captured images needed to clearly show the key identifying features of the plant, such as leaf shape, venation patterns, flower structure, and overall plant habit. These images could be compared to visual references in plant identification books or online databases to narrow down the possible species. Alternatively, the images could be shared with plant experts, such as botanists or horticulturists, who provided guidance on the identification based on their knowledge and experience. By combining visual references and expert knowledge, the plant species could be accurately identified from the captured images.

3.3.4 Data Article Review

For further analysis and a deeper understanding of dusky leaf monkey food selection, the 10 most frequently selected plant species during the study period were used for detailed chemical analysis. By referring to relevant scientific journals, chemical and nutritional compounds can be identified and measured that are present in certain parts of this plant, such as leaves and fruits. Data on chemical content and nutrition was collected to identify the percentage taken by dusky leaf monkeys to better understand their food choices and the chemical and nutritional content required to meet their daily dietary needs. Samples of various plant species consumed by the dusky leaf monkeys were analyzed for their chemical composition, including secondary metabolites, protein, lipids, and carbohydrates. This information was crucial for understanding the foraging behavior and dietary adaptations of dusky leaf monkeys, which could have important implications for their conservation and management in their natural habitats.

CHAPTER 4

RESULT & DISCUSSION

4.1 Result & discussion

Table 4.1 provides a comprehensive overview of the plant species consumed by the Dusky leaf monkey during the study period. The table lists various species, their local names, and the specific parts of the plants that are eaten. This information highlights the dietary preferences of the Dusky leaf monkey, which primarily consumes young leaves, fruits, and other plant parts, reflecting its folivores nature. The variety of species consumed indicates the monkey's adaptability and the ecological significance of these plants in its habitat.

Table 4.1: list of plant species

No.	Species name	Local name	Consumed parts
1	*Naphelium lappaceum*	Rambutan	Unripe Fruit
2	*Elais guineensis*	Palm oil	Fruit
3	*Albizia saman*	raintree	Young leaves,
4	*Ficus macrocarpa*	malayan banyan	Young leaves, fruit
5	*Moringa oleifera*	merungai	Young leaves
6	*Averrhoa carambola*	Star fruit	Fruit
7	*Mangifera indica*	Manggo	Unripe Fruit
8	*Terminalia catappa*	Ketapang	Leaves
9	*Manihot esculenta*	pokok ubi kayu	Young Leaves
10	*Phyllanthus acidus*	cermai	Fruit
11	*Mikania micrantha*	akar lupang	Leaves
12	*Pterocarpus indicus*	angsana/sena	Leaves
13	*Bougainvillea*	bunga kertas	Young leaves
14	*Pyrrosia piloselloides*	pokok duit duit	Leaves
15	*Artocarpus heterophyllus*	nangka	Young leaves
16	*Red soil*	-	soil
17	*Acacia auriculifomis*	darwin blackwattle	Young leaves
18	*Piper betle*	sirih	Leaves
19	*Melonthria pendula L.*	creeping cucumber	Leaves, Fruit

Dusky leaf monkeys are categorized as social monkeys since they are frequently observed interacting with members of their own social group. In this study area, the species is found as many as 12-18 individuals in a group consisting of adults, sub-adults and infants. The total effort for this sampling was over 20 days. On a few of the study days, it rained, which prevented the study participants from leaving the building. The study group was observed from 0730 until 1910, during which their daily activities varied. However, because of its shyness, increased stealth, and erratic behaviour, the species is rarely observed (Karimmullah, 2014). As folivores, dusky leaf monkeys mostly eat leaves, though they occasionally eat fruits, flowers, and seeds. They can process difficult plant materials with efficiency with their unique digestive mechanism (Yap et al,2019). Based on the Table 4.1, showing that the species and part of plant that have been eat such as leaves, young leaves and fruit.

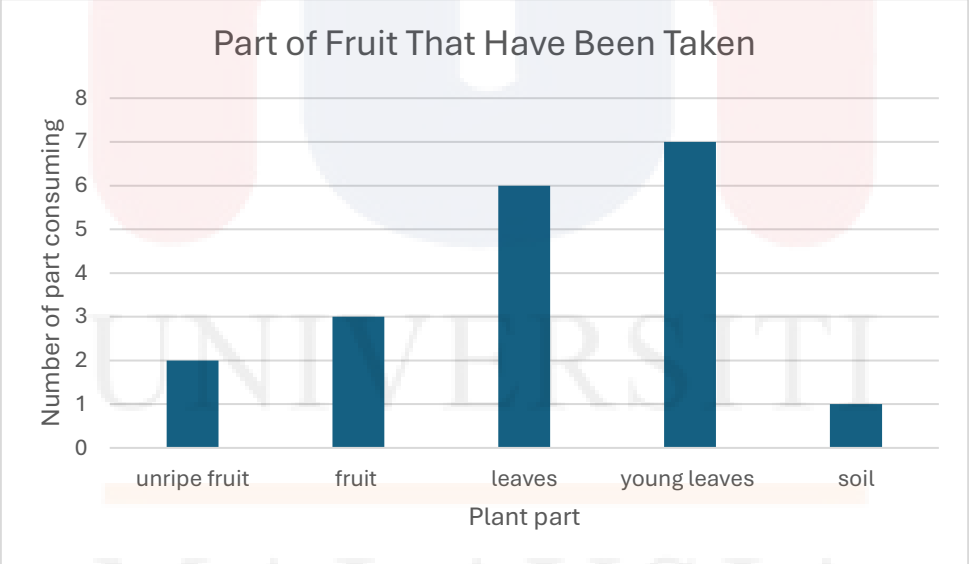

Figure 4.1: The graph shows the part consume by dusky leaf monkey

Based on the graph at Figure 4.1, the highest consumed part of the plant is leaves followed by young leaves, fruit and unripe fruits. This consumption pattern indicates a strong preference for foliage in the diet of the species studied. *Trachypithecus* was reported to rely more on leaves compared than any other Asian colobine (Suarez, 2013). Leaves, being the most consumed part, provide a staple food source rich in various nutrients essential for their diet. The next most consumed part, young leaves (Figure 4.2 (b)), are particularly favoured likely due to their higher protein content and greater water availability, which make them more nutritious and easier to digest compared to mature leaves they consume more young leaves than mature leaves (Suarez, 2013) as young leaves contain more proteins and water and less fiber and tannins (Takemoto, 2003). This dietary diversity highlights the adaptability and selective feeding habits of the species in utilizing available plant resources efficiently. Beside feeding on plants part (leaves, fruit, and flower) this langur also eats red soil (Figure 4.2.(a)). Dusky leaf monkey frequently consumes invertebrates that live in plants, soil, and tree bark to obtain nutrients like protein and sodium (Rahman et al, 2015).

(a) (b)

Figure 4.2: show dusky leaf monkey feed on red soil (a) and young leaf (b)

Table 4.2: list of chemical and nutrition content.

No	Species	Part	water contain / moisture	Protein	Carbohydrate	Calcium	Fiber	Fat	Citation
1	*Nephelium lappaceum* (Rambutan)	Fruit	83g	0.8g	14.5g	25mg	-	-	(Hernández-Hernández et al., 2019)
2	*Elais guineensis* (Palm oil)	Fruit	0.32g	2.79g	1.33g	-	0.31g	0.17g	(Odunayo Akinyeye et al., 2011)
3	*Albizia saman* (raintree)	Fruit	-	22.16 ±0.25%	-	-	25.48 ±0.29%	-	(Chitra & Balasubramanian, 2016)
4	*Ficus macrocarpa* malayan banyan	Fruit	63.45 -60.23%	11.0- 60.27%	51-62.8%	-	-	1.31-60.11%	(Rjeibi et al., 2017)
5	*Ficus macrocarpa* malayan banyan	Leaf	76.23-60.94%	14.18-60.71%	22.1-61.5%	-	-	5.03-60.20%	(Rjeibi et al., 2017)
6	*Moringa oleifera* (merungai)	Leaf	9.0 ± 0.17mg	28.65 ± 0.04mg	44.36mg	2.97mg	-	-	(Teixeira et al., 2014)
7	*Averrhoa carambola* (Star fruit)	Fruit	-	0.38g	9.38g	4.4-6.0mg	0.80g-0.90g	0.8g fat	(Dasgupta et al., 2013) (Lakmal et al., 2021)
8	*Mangifera indica* (Mango)	Fruit	78.9–82.8g	0.36–0.40g	16.20–17.18g	9 - 21 mg	0.85–1.06g	-	(Maldonado-Celis et al., 2019)
9	*Terminalia catappa* (Ketapang)	Leaf	5.50 ± 0.88g	20.14 ± 0.95g	-	-	-	-	(Oliveira et al., 2000)
10	*Manihot esculenta* (pokok ubi kayu)	Leaf	64.8-88.6g	1.0-10.0g	7-18 g	34-708mg	0.5-10.0g	-	(Zekarias et al., 2019)
11	*Phyllanthus acidus* (cermai)	Fruit	91.7mg	0.7mg	6.4mg	-	0.51mg	0.52mg	(Brooks et al., 2020)

Based on the table 4.2, The water content in *Nephelium lappaceum* is the highest with 87g per 100g of the whole weight of the fruit compared to the fruit and leaves of other species. The water content is one of the highest compared to other nutrients for the 10 species that are valued (Table 4.2) food selection with the highest water contain can impact the feeding behaviour of the langurs during the dry season when the water availability may be limited (Wang et al., 2022). While *Ficus macrocarpa* fruit has the highest protein content (51-62.8%). the presence of high carbohydrates in the nutritional composition plays an important role for langurs in forming the gut microbiota of langurs, as evidenced by studies on captive and wild Francois' langurs (Mo et al., 2023). However, various studies on langurs and other foregut fermenting primates have shown that a diet high in fiber enhances the quality of their stool and improves digestive function (Nijboer, 2006b). Furthermore, better-quality feces are produced by langurs who eat less digestible carbohydrates and more fiber, highlighting the significance of diet composition in captive langurs (Sha, 2014).

However, the food that is readily available to dusky leaf monkeys greatly affects their diet. Dusky leaf monkeys ate mostly leaves and fruits, with anthropogenic foods being consumed in significant amounts, according to research on sympatric primates conducted in Malaysia (Akbar et al., 2022). The fruit consumption of the monkeys and their monthly fruit availability were found to positively correlate in the study, suggesting that the monkeys preferred fruits as a food source (Ruslin et al., 2018). Furthermore, the feeding habits of wild silvery langurs, a different species of primate, were influenced by the availability of young leaves and ripe fruit, with a negative correlation between the two food sources (Zhang et al., 2018). These results demonstrate how environmental factors impact the feeding ecology of Dusky Leaf Monkeys and highlight the significance of food availability in determining the dietary preferences and patterns of these animals.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Dusky leaf monkeys have shown that they have diverse diet by consuming a variety of plant parts (leaves, young leaves, fruit, and unripe fruit). Based on the research the highest consuming part were young leaves, followed by leaves, fruit and unripe fruit indicating a strong preference for foliage in their diet. The consumption of young leaves over mature leaves is likely due to their higher protein content and greater water availability, making them more nutritious and easier to digest. In addition to plant materials, the monkeys were also observed consuming red soil, likely to obtain nutrients like protein and sodium. The plant species consumed by the dusky leaf monkeys had varying nutritional compositions, with differences in water, protein, carbohydrate, calcium, and fiber content. The high-water content in some fruits, such as rambutan, may be particularly important during the dry season when water availability is limited. The presence of high carbohydrates in the diet plays a crucial role in shaping the gut microbiota of the dusky leaf monkey, while a diet rich in fiber enhances digestive function and stool quality.

The feeding habits of the dusky leaf monkeys are strongly influenced by the availability of different food sources in their environment. Studies on sympatric primates have shown a positive correlation between fruit consumption and monthly fruit availability, suggesting that the monkeys prefer fruits when they are readily available. Conversely, the feeding patterns of other langur species have been found to be negatively correlated between young leaves and ripe fruits, highlighting the importance of environmental factors in determining dietary preferences. Valuable insights into the feeding ecology of the dusky leaf monkey, revealing their dietary diversity, nutritional preferences, and the influence of food availability on their feeding behaviour. These findings contribute to a better understanding of the adaptability and resource utilization strategies of this primate species, which is crucial for their conservation and management.

5.2 Recommendation

The data obtained in this study could be used as a baseline for the future and further study especially to understanding the feeding ecology and chemical content consumed by dusky leaf monkey. The findings of this study could inform conservation efforts for dusky leaf monkeys. Firstly, sampling effort to collect the data of plant species that have been eaten by dusky leaf monkey needs to be done in different month or season for further understanding of the food chosen. Next the chemical analysist should be done in the lab for a better and precise result to confirm the chemical content in the plant species that have been eaten by dusky leaf monkey. The behaviour of this species as a pest is a significant concern, as several residents in the neighbourhood report issues caused by these primates in residential areas.

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